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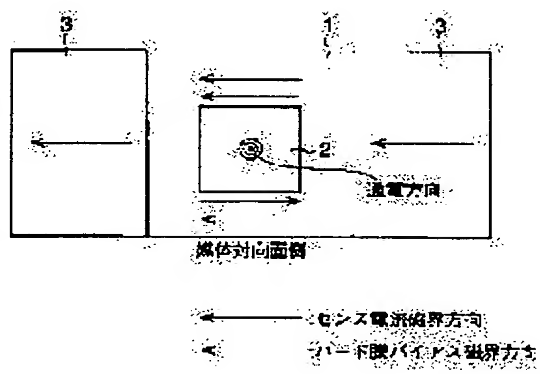
(54) VERTICAL-CONDUCTION-TYPE MAGNETIC RESISTANCE EFFECTIVE ELEMENT, MAGNETIC HEAD, AND MAGNETIC RECORDING/ REPRODUCING APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a magnetic head including a vertical-conduction-type magnetoresistance effect element that can reduce the influence due to a vertical conduction magnetic field.
SOLUTION: A magnetic resistance effect film (1), an electrode (1), and a bias application film (3) are provided. The electrode (2) is arranged so that current is vertically energized onto the surface of the magnetoresistance effect film (1). The bias application film (3) is formed near the magnetoresistance effect film (1), and gives a bias magnetic filed in a specific direction to the magnetoresistance effect film (1). At a side where the signal flux of the magnetoresistance effect film (1) flows in, the direction of a magnetic field in the bias application film (3) and the direction of the magnetic field generated by the current are not in parastate. Cancellation is made by the bias magnetic field and a sense current one at a portion where medium flux flows into a sensor magnetism detection section, thus suppressing reduction in permeability at the portion, and hence increasing the sensitivity of a sensor.



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CLAIMS

[Claim(s)]
[Claim 1] The magneto-resistive effect film and the electrode of the pair which enables energization of a current in the perpendicular direction to the film surface of said magneto-resistive effect film, Provide the bias impression film which gives a bias field in the parallel direction to the film surface of said magneto-resistive effect film, and near the inflow part of the signal magnetic flux in said magneto-resistive effect film The perpendicular energization mold magneto-resistive effect component characterized by the direction of the field of said bias impression film and the direction of the field generated according to the current energized in the perpendicular direction to the film surface of said magneto-resistive effect film serving as anti-parallel substantially.
[Claim 2] The magneto-resistive effect film and the electrode of the pair which enables energization of a current in the perpendicular direction to the film surface of said magneto-resistive effect film, The bias impression film which gives a bias field in the parallel direction to the film surface of said magneto-resistive effect film, The magnetic layer prepared so that signal magnetic flux might be led to said magneto-resistive effect film near the inflow part of the signal magnetic flux in said magneto-resistive effect film is provided. The perpendicular energization mold magneto-resistive effect component characterized by the direction of the field of said bias impression film and the direction of the field generated according to the current energized in the perpendicular direction to the film surface of said magneto-resistive effect film serving as anti-parallel substantially in said magnetic layer.
[Claim 3] The perpendicular energization mold magneto-resistive effect component according to claim 1 characterized by being formed so that the edge by the side of the medium opposed face of said magneto-resistive effect film and the edge by the side of the medium opposed face of said bias impression film may become the same flat-surface top.
[Claim 4] The perpendicular energization mold magneto-resistive effect component according to claim 2 characterized by being formed so that the edge by the side of the medium opposed face of said magnetic layer and the edge by the side of the medium opposed face of said bias impression film may become the same flat-surface top.
[Claim 5] The magneto-resistive effect component according to claim 1 to 4 to which said magneto-resistive effect film is characterized by having the structure which sandwiched the nonmagnetic conductive layer between two-layer ferromagnetic layers.
[Claim 6] The magnetic head equipped with a perpendicular energization mold magneto-resistive effect component according to claim 1 to 5.
[Claim 7] The magnetic recorder and reproducing device characterized by providing a magnetic-recording medium and the magnetic head according to claim 6.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the magnetic head containing a perpendicular energization mold magneto-resistive effect component and a perpendicular energization mold magneto-resistive effect component, and the magnetic recorder and reproducing device which carried this magnetic head.
[0002]
[Description of the Prior Art] In recent years, in magnetic recording media, such as a hard disk drive unit, small and densification are progressing quickly and it counts upon densification being carried out further from now on. In order to attain densification in magnetic recording, while narrowing recording track width of face and raising a recording track consistency, it is necessary to raise, the recording density, i.e., the track recording density, of a longitudinal direction.
[0003] However, by the longitudinal recording method within a field, while an anti-field becomes large and causes the fall of a playback output as recording density becomes high, there is a trouble of it becoming impossible to perform stable record. In order to improve these troubles, the vertical recording method is proposed. A vertical recording method magnetizes and records a record medium on a film surface and a perpendicular direction, as compared with a longitudinal recording method, even if it raises recording density, there is little effect of an anti-field and the fall of a playback output etc. is controlled.
[0004] Conventionally, with an induction type head, although the induction type head has been used for playback of a medium signal for the longitudinal recording method and the vertical recording method, if the magnitude of magnetization which recording track width of face became narrow, and was recorded in connection with densification becomes small, sufficient regenerative-signal output will no longer be obtained. Then, even if the magnitude of the recorded magnetization became small, the AMR head with high playback sensibility using an anisotropy magneto-resistive effect (AMR) is developed, and it came to be used as the shielding mold reproducing head so that sufficient regenerative-signal output may be obtained. Recently, the spin bulb mold GMR head adapting giant magneto-resistance (GMR) with more high sensibility is used.
[0005] Furthermore, development of the magnetic head using the tunnel magneto-resistive effect (TMR) and CPP (Current Perpendicular to the Plane)-GMR component it is expected that high playback sensibility is, and research for utilization are also advanced. With these components, a sense current is perpendicularly passed by the film surface. The CPP-GMR component is indicated by JP,10-55512,A and the U.S. Pat. No. 5,668,688 official report. Thus, the magnetic head with high playback sensibility is developed, and by using them, even if record bit size becomes very small, playback of a record signal is attained.
[0006] In order to raise the track recording density of a recording track, it is necessary to narrow the gap of the magnetic head. In the magnetic head using the conventional magneto-resistive effect, the magneto-resistive effect component is formed in the head gap specified spacing during one pair of shielding. When a spin bulb GMR head also needs about 30nm as thickness of a magneto-resistive effect component and takes the insulation with shielding into consideration also with the AMR head, about 100nm is needed as spacing during shielding. Thus, in the conventional magnetic head, the limit which can narrow a head gap is about 100nm, and when raising track recording density, big constraint has produced it. The structure which forms a flux guide in a medium opposed face side, and the sensor section is retreated from a medium opposed face, and forms it from such a background since it corresponds to narrow gap-ization is proposed. Especially, it is necessary to install the electrode of a GMR component and a vertical pair between shielding, and such thickness serves as big constraint to narrow-gap-izing with the CPP-GMR component. So, in order to correspond to narrow gap-ization with a CPP-GMR component, it is effective that form a flux guide in a medium opposed face side, retreat an electrode section from a medium opposed face, and only a thin flux guide is arranged between shielding in a medium opposed face.
[0007] In order to control the Barkhausen noise (Barkhausen noise) in the magneto-resistive effect film, it is effective to install the bias film in the both ends of the magneto-resistive effect film, and to impress a bias field. However, when distance between bias film was narrowed as ** truck-ization progressed for the improvement in recording density, since a bias field started the magneto-resistive effect film too much strongly and flux reversal became difficult, this invention persons found out that the problem that the sensibility of a component falls arose.
[0008] Moreover, with the CIP(Current In Plane)-GMR component which energizes a sense current, the operating point was decided in the conventional film surface by balancing three fields of the current field which a sense current makes, the magnetostatic joint field from a pin layer to a free layer, and the layer joint field between pin

layer-free layers. Since a sense current field is circularly added to a current core, it becomes impossible however, to use the design technique of the operating point mentioned above with the component which energizes a sense current at right angles to a film surface. And in the edge section of the electrode with which a sense current field supplies a sense current, most strongly, for this reason, the inflow of the medium magnetic flux to the magneto-resistive effect film of the electrode lower part which is a sensor magnetic force sencor is barred, and the sensibility of a sensor falls.

[0009] Solution sufficient with the configuration which these problems are suggested to neither JP,10-55512,A mentioned above nor U.S. Pat. No. 5,668,688, but is indicated by these reference is a difficult technical problem.

[0010] The problem that the inflow of medium magnetic flux is checked by the sense current field mentioned above becomes so remarkable that recording density increases (i.e., so that the size of the magneto-resistive effect component which is a sensor, and an electrode becomes small). For example, since it corresponds to the recording density exceeding 100Gbpsi, if size of an electrode is made below into 1 micrometer**, the inflow of the medium magnetic flux to the magneto-resistive effect film of the electrode lower part will be barred. Since it is necessary to energize a big sense current in order to obtain a certain amount of output when especially the size of an electrode is small, an above-mentioned trouble becomes remarkable.

[0011] (Electrode size and GMR film size) actually produced four kinds of CPP-GMR components which are (0.3micrometer**, 0.7micrometer**), (0.2micrometer**, 0.5micrometer**), and (0.1micrometer**, 0.3micrometer**), respectively (0.5micrometer**, 1.2micrometer**), the 5mA sense current was energized, and flux density distribution of the GMR film in the condition that the sense current field was added was investigated. Consequently, it was admitted that the flux density of the GMR film became strong notably in the edge section of an electrode compared with other fields with the CPP-GMR component whose (electrode size and GMR film size) are (0.5micrometer**, 1.2micrometer**) as electrode size becomes small, although the flux density of the GMR film was small enough. The relation between electrode size and the maximum magnetic flux density in a hysteresis loop of the GMR film in the edge section of an electrode is shown in drawing 22 . Moreover, the relation between the magnitude of a sense current and the maximum magnetic flux density in a hysteresis loop of the GMR film in the edge section of an electrode is shown in drawing 23 about the CPP-GMR component whose (electrode size and GMR film size) are (0.1micrometer**, 0.3micrometer**).

[0012] These results are judged synthetically, when electrode size is [a sense current value] 1mA or more below in 0.3 micrometer**, measures with which the inflow of the medium magnetic flux to the electrode lower part is not barred when a sense current value is 3mA or more below in 0.1 micrometer** are taken especially, and it is necessary to raise the sensibility of a sensor.

[0013] Moreover, in magnetic storage, such as a hard disk, the flying height which is the distance of the magnetic head and a storage is falling gradually as high recording density-ization progresses. The fall of such the flying height means that the probability for a head to collide with the slight projection of a storage increases, and TA (Thermal Asperity) noise actually poses a problem. Therefore, it is desirable to adopt the head structure of the York mold which draws magnetic flux in a magneto-resistive effect component through York so that a magneto-resistive effect component may not be exposed to a direct medium opposed face. Since the level York mold magnetic head which prepares a magneto-resistive effect component also among the York mold magnetic heads so that the film surface may be parallel to a medium opposed face can install the whole magneto-resistive effect component near the medium, it is advantageous. Also in such the York mold magnetic head, when a strong bias field is impressed or a strong sense current field is impressed, there is a problem that the sensibility of a sensor falls and it is necessary to raise the sensibility of a sensor.

[0014]

[Problem(s) to be Solved by the Invention] The purpose of this invention is to offer the magnetic head containing the perpendicular energization mold magneto-resistive effect component which can reduce the effect of a perpendicular energization field and a bias field, and can raise sensibility, and this perpendicular energization mold magneto-resistive effect component, and the magnetic recorder and reproducing device which carried this magnetic head.

[0015]

[Means for Solving the Problem] The perpendicular energization mold magneto-resistive effect component which takes like 1 voice as for this invention The magneto-resistive effect film and the electrode of the pair which enables energization of a current in the perpendicular direction to the film surface of said magneto-resistive effect film, Provide the bias impression film which gives a bias field in the parallel direction to the film surface of said magneto-resistive effect film, and near the inflow part of the signal magnetic flux in said magneto-resistive effect film It is characterized by the direction of the field of said bias impression film and the direction of the field generated according to the current energized in the perpendicular direction to the film surface of said magneto-resistive effect film serving as anti-parallel substantially.

[0016] The perpendicular energization mold magneto-resistive effect component concerning other modes of this invention The magneto-resistive effect film and the electrode of the pair which enables energization of a current in the perpendicular direction to the film surface of said magneto-resistive effect film, The bias impression film which gives a bias field in the parallel direction to the film surface of said magneto-resistive effect film, The magnetic layer prepared so that signal magnetic flux might be led to said magneto-resistive effect film near the inflow part of the signal magnetic flux in said magneto-resistive effect film is provided. It is characterized by the direction of the field of said bias impression film and the direction of the field generated according to the current energized in the

perpendicular direction to the film surface of said magneto-resistive effect film serving as anti-parallel substantially in said magnetic layer.
[0017] The magnetic layer prepared in the side into which the signal magnetic flux of the above-mentioned magneto-resistive effect film flows functions as a flux guide which introduces signal magnetic flux to the magneto-resistive effect film. Among magneto-resistive effect film, the whole magneto-resistive effect film is sufficient, and soft magnetism layers, such as NiFe prepared apart from the magneto-resistive effect film, are [the magnetic layer which extended the free layer to the medium opposed face side, and was formed is sufficient as this magnetic layer, and] sufficient as it.
[0018]
[Embodiment of the Invention] The magneto-resistive effect film may be TMR film, or may be CPP-GMR film. What has the structure which sandwiched the conductive nonmagnetic interlayer, for example between two-layer ferromagnetic layers as GMR film contained in the CPP-GMR film is mentioned. With this structure, when one ferromagnetic layer carries out the laminating for example, of the antiferromagnetism layer, the ferromagnetic layer of another side functions as a magnetization fixing layer (pin layer) which magnetization fixed as a magnetization free layer (free layer) which magnetization rotates freely by the external magnetic field. in addition, these layers -- in addition, a substrate layer, a protective layer, etc. may be prepared.
[0019] As bias impression film, antiferromagnetism film, such as hard magnetic films, such as CoPt, and PtMn, IrMn, can be used. The bias impression film of a pair is prepared in the both sides of the magneto-resistive effect film so that a bias field may be impressed in the predetermined direction along with the film surface of the magneto-resistive effect film. The bias impression film may be adjoined and installed in the both sides of the magneto-resistive effect film, may be installed in the bottom of the both sides of the magneto-resistive effect film, or a top, and it may be installed so that a part of both sides of the magneto-resistive effect film may be made to overlap. As for these installation approaches, it is desirable to choose according to magnetic properties and thickness of the bias impression film in combination which requires the optimal bias field for the magneto-resistive effect film.
[0020] The electrode of a pair is prepared in the upper and lower sides of the magneto-resistive effect film so that a current may be energized in the almost perpendicular direction to the film surface of the magneto-resistive effect film. An electrode may be formed by electric conduction film, such as Cu, and may use the parts of parts other than the free layer of the magneto-resistive effect film, for example, a protective coat, the antiferromagnetism film, and a pin layer as an electrode. As for these electrodes, it is desirable to prepare in the center section of the magneto-resistive effect film so that it may separate from the bias impression film prepared in the both sides of the magneto-resistive effect film and may retreat from a medium opposed face. Thus, if an electrode is prepared, the magneto-resistive effect film which exists between an electrode and a medium opposed face will function as a flux guide. In addition, as mentioned above, a part of free layer which extended and was formed in the medium opposed face side is sufficient as a flux guide, and the soft magnetism layer prepared apart from the magneto-resistive effect film is sufficient as it. Thus, the electrode with which the magneto-resistive effect film was installed up and down is making the pillar configuration, can avoid the field where it is near the bias impression film, and sensibility becomes low in response to a strong bias field, and can extract and energize a sense current only on the magneto-resistive effect film of the field where sensibility is high. For this reason, when the GMR film is used as magneto-resistive effect film, it is advantageous to making current distribution in that film the optimal. In addition, since it is difficult for the magneto-resistive effect film to form the electrode of the almost same magnitude without a location gap up and down, it is desirable to mitigate the effect of a location gap error by making one of electrodes large compared with the electrode of another side.
[0021] When preparing the magnetic layer considered as a flux guide apart from the magneto-resistive effect film, as for this magnetic layer, it is desirable to become the configuration which touches the free layer of the magneto-resistive effect film, but if installation of magnetic flux is possible in a free layer, it will not be limited to this configuration. For example, the free layer and the magnetic layer as a flux guide do not need to touch, and a nonmagnetic thin adhesion layer etc. may be minded among these.
[0022] Moreover, although it is desirable to become the configuration which touches the bias impression film as for the magnetic layer as a flux guide, if impression of sufficient bias field for extent in which magnetization is stabilized by the bias impression film at the edge of this magnetic layer is possible, it will not be limited to this configuration. For example, the magnetic layer which carries out a flux guide with the bias impression film does not need to touch, and the nonmagnetic thin adhesion film etc. may be minded among these.
[0023] As for the bias impression film, it is desirable to prepare in the both sides of the magneto-resistive effect film including a flux guide. In this case, the edge by the side of the medium opposed face of a flux guide may be formed so that it may become the same flat-surface top as the edge by the side of the medium opposed face of the bias impression film. Moreover, a part of edge by the side of the medium opposed face of a flux guide may be formed so that it may project to a medium side rather than the edge by the side of the medium opposed face of the bias impression film.
[0024] With the perpendicular energization mold magneto-resistive effect component of this operation gestalt, the field of the bias impression film and the sense current field energized at right angles to the film surface of the magneto-resistive effect film become the side by which signal magnetic flux flows into a sensor magnetic force sencor with anti-parallel substantially, and it works in the direction negated mutually. For this reason, the permeability of the side which flows into a sensor magnetic force sencor can be raised, and the signal magnetic flux of the magneto-resistive effect film can obtain the operating point when a magneto-resistive effect component is

the optimal, and can raise the sensibility of a sensor. In addition, it is not necessary to necessarily negate a bias field and a sense current field completely, and if single domain-ization is attained applying a weak bias field to a signal magnetic-flux inflow side rather, they can also control a Barkhausen noise. Thus, if it is made for a sense current field and a bias field to serve as anti-parallel and each field is appropriately set to a medium opposed face side, two effectiveness of the improvement in an output and Barkhausen noise control can be reconciled.

[0025] Moreover, when the edge by the side of the medium opposed face of a flux guide and the edge by the side of the medium opposed face of the bias impression film are formed so that it may become the same flat-surface top, there is an advantage that a bias field becomes stability in a flux guide, and also a production process also becomes easy.

[0026] This operation gestalt is especially effective, when an electrode is made small and a sense current value is enlarged, since it corresponds to high recording density-ization. Especially, when electrode size is [a sense current value] 1mA or more below in 0.3 micrometer**, when a sense current value is 3mA or more below in 0.1 micrometer**, specifically, remarkable effectiveness is acquired.

[0027] the side into which, as for the sense current I, the signal magnetic flux of the magneto-resistive effect film flows -- the direction of a bias field -- receiving -- substantial -- anti- -- when the case where it energizes so that a sense current field [****] may occur is made into the direction of +, it is desirable to set it as the range of 0< I<20mA. If this condition is fulfilled, it will become compatible [the improvement in an output, and Barkhausen noise control]. Although it is desirable at this time to enable it to oppose bias magnetic field strength in sense current magnetic field strength, if a sense current is too large, generation of heat of a component will pose a problem. It is more desirable to set the sense current I as the range of 3<=I<=15mA from these viewpoints.

[0028] In the perpendicular energization mold magneto-resistive effect component of other operation gestalten, the die length of the opposed face to signal magnetic flux may make the magneto-resistive effect film larger than the depth from the opposed face to signal magnetic flux. In this case, a shape anisotropy field is given to the magneto-resistive effect film, and magnetization of the magneto-resistive effect film becomes stability at a longitudinal direction. Moreover, since a sense current field, a bias field, and a shape anisotropy field are impressed, while raising the permeability of the magneto-resistive effect film and coming to stabilize the optimal operating point, single domain-ization of the magneto-resistive effect film also becomes easy, and can raise sensibility as a result.

[0029] In the perpendicular energization mold magneto-resistive effect component of the operation gestalt of further others, the die length of the opposed face to signal magnetic flux may make an electrode larger than the depth from the opposed face to signal magnetic flux. In this case, a sense current field becomes linear and the above-mentioned effectiveness comes to be acquired by stability.

[0030] The above perpendicular energization mold magneto-resistive effect components are applicable to a shielding mold head combining one pair of magnetic shielding formed so that this might be inserted. In this case, a flux guide is prepared in the medium opposed face side of the magneto-resistive effect film, and only a flux guide is arranged between shielding and it is made for a bias field and the field generated according to the sense current energized at right angles to the film surface of the magneto-resistive effect film to serve as anti-parallel substantially by the medium opposed face side in a medium opposed face.

[0031] The above perpendicular energization mold magneto-resistive effect components are also applicable to the York mold head combining magnetic York where signal magnetic flux is introduced. For example, what is necessary is just to make it the direction of the field generated according to the sense current which arranges in the location corresponding to the part which shifts an electrode from right above [gap] in the case of a level York mold, and becomes an insensitive part substantially on York etc., and is energized at right angles [in the part of the magneto-resistive effect film of gap right above highest / of sensibility] to the direction of a bias field and a film surface serve as anti-parallel substantially.

[0032] In the operation gestalt of further others, the magnetic recorder and reproducing device which has a magnetic-recording medium and the above magnetic heads is also offered. In case magnetic recording is reproduced using this magnetic recorder and reproducing device, a sense current is energized so that the direction of the field of the bias impression film and the direction of the field generated according to the sense current energized at right angles to the film surface of the magneto-resistive effect film may serve as anti-parallel substantially by the side into which the signal magnetic flux from a magnetic-recording medium flows.

[0033] Hereafter, it explains, referring to a drawing about the operation gestalt of this invention. Drawing 1 is the top view of the perpendicular energization mold magneto-resistive effect component concerning 1 operation gestalt. In this drawing, the bottom serves as a medium opposed face. As magneto-resistive effect film 1, the tunnel junction mold magneto-resistive effect film (TMR film) or the CPP-GMR film is used, and the laminating of the film is carried out in the direction which intersects perpendicularly with space. The electrode 2 which consists of Cu is formed in the upper and lower sides of the magneto-resistive effect film 1. The bias impression film 3 and 3 which becomes the both sides of the magneto-resistive effect film 1 from CoPt is arranged.

[0034] The example of the TMR film is shown in drawing 2 . The TMR film of drawing 2 has the structure which carried out the laminating of the protective layer 26 which consists of the substrate layer 21 which consists of Ta, the antiferromagnetism layer 22 which consists of PtMn, the magnetization fixing layer (pin layer) 23 which consists of three layer membranes of CoFe/Ru/CoFe, the tunnel junction layer 24 which consists of AlOx, a magnetization free layer (free layer) 25 which consists of bilayer film of CoFe/NiFe, and Ta.

[0035] The example of the CPP-GMR film is shown in drawing 3 . The CPP-GMR film of drawing 3 has the structure which carried out the laminating of the protective layer 36 which consists of the substrate layer 31 which consists

of Ta, the antiferromagnetism layer 32 which consists of PtMn, the magnetization fixing layer (pin layer) 33 which consists of three layer membranes of CoFe/Ru/CoFe, the nonmagnetic interlayer (spacer layer) 34 who consists of Cu, a magnetization free layer (free layer) 35 which consists of bilayer film of CoFe/NiFe, and Ta.
[0036] In addition, the built-up sequence of each class of the TMR film or the CPP-GMR film may be drawing 2 or drawing 3 , and reverse. Moreover, the TMR film or the CPP-GMR film may serve as a dual mold with which the pin layer was prepared in the vertical symmetry focusing on the free layer.
[0037] Drawing 4 is the sectional view of the perpendicular energization mold magneto-resistive effect component of drawing 1 . As shown in this drawing, the bias impression film 3 and 3 is adjoined and installed in the both sides of the magneto-resistive effect film 1. In addition, the bias impression film may be arranged by the method as shown in drawing 5 or drawing 6 . Drawing 5 shows the case where the magneto-resistive effect film 1 is made to overlap to the bias impression film 3 and 3. Drawing 6 shows the case where the bias impression film 3 and 3 is installed on the magneto-resistive effect film 1.
[0038] When using a hard magnetic film like CoPt as bias impression film 3 and 3, the structure of drawing 4 or drawing 5 is desirable. When using antiferromagnetism film like PtMn as bias impression film 3 and 3, the structure of drawing 5 or drawing 6 is desirable.
[0039] As shown in drawing 1 , the magnetization direction of the bias impression film 3 and 3 which consists of CoPt is set up in the leftward direction of drawing. A sense current is energized upward from under space to an electrode 2 at right angles to the film surface of the magneto-resistive effect film 1, and a sense current field generates it in the direction shown by the arrow head of drawing centering on an electrode 2. Consequently, the direction of the field of the bias impression film 3 and the direction of the field generated according to the current energized at right angles to the film surface of the magneto-resistive effect film 1 serve as anti-parallel substantially by the medium opposed face side into which the signal magnetic flux from a medium flows. Thus, since a bias field and a sense current field work in the direction negated mutually by the medium opposed face side, the signal magnetic flux of the magneto-resistive effect film 1 can control decline in the permeability of the side which flows into a sensor magnetic force sencor. Moreover, since medium magnetic flux flows into the magneto-resistive effect film directly under an electrode which is a magnetic force sencor, without being barred by the sense current field, it can maintain sensibility. On the other hand, in a medium opposed face and the opposite side, since both fields overlap, a strong bias field is added, and the permeability in the part falls. However, this part is not a magnetic force sencor, either, and since it does not contribute to the suction of medium magnetic flux, either, it does not pose a problem.
[0040] Drawing 7 is the top view of the perpendicular energization mold magneto-resistive effect component concerning other operation gestalten. The component of drawing 7 has the same structure as drawing 1 except having retreated and having formed the bias impression film 3 rather than the medium opposed face of the magneto-resistive effect film 1.
[0041] With this structure, when the field from the bias film is too strong like [when the distance between bias film is narrow], it becomes possible to apply the field of moderate magnitude to the medium opposed face side of the magneto-resistive effect film 1, for example.
[0042] Drawing 8 and drawing 9 are the top views of the perpendicular energization mold magneto-resistive effect component concerning other operation gestalten, respectively. The component of drawing 8 has the same structure as drawing 1 except having lost the part of the magneto-resistive effect film 1 which has not lapped with the electrode 2 in a medium opposed face and the opposite side. Moreover, the component of drawing 9 has the same structure as drawing 7 except having lost the part of the magneto-resistive effect film 1 which has not lapped with the electrode 2 in a medium opposed face and the opposite side.
[0043] Since the part to which a bias field and a sense current field overlap a medium opposed face in the opposite side, permeability falls, and it is hard coming to move magnetization by the component of drawing 8 or drawing 9 is lost, it can prevent being hard coming to move magnetization of other parts under the effect of the part, and the fall of sensibility can be prevented as a whole.
[0044] Drawing 10 is the top view of the perpendicular energization mold magneto-resistive effect component concerning other operation gestalten. The magneto-resistive effect film 1 in this component has the die length larger than the depth from a medium opposed face which meets a medium opposed face, and has the same structure as drawing 8 except being an oblong configuration along with the medium opposed face. In this case, since lateral shape anisotropy can be given to the magneto-resistive effect film 1 and an anisotropy field can be added to a bias field from the bias impression film 3 and 3, the magneto-resistive effect film 1 can be single-domain-ized easily.
[0045] Drawing 11 and drawing 12 are the top views of the perpendicular energization mold magneto-resistive effect component concerning other operation gestalten, respectively. The component of drawing 11 has the same structure as drawing 10 except having retreated and having formed the bias impression film 3 rather than the medium opposed face of the magneto-resistive effect film 1. The component of drawing 12 has the same structure as drawing 11 except making width of face for a lobe of the magneto-resistive effect component 1 by the side of a medium opposed face into width of face almost comparable as an electrode 2.
[0046] With such structures, while making the magneto-resistive effect film easy to add a shape anisotropy field to the magneto-resistive effect film with a bias field, and to single-domain-ize, when the field from the bias film is too strong like [when the distance between bias film is narrow], it becomes possible to apply the field of moderate magnitude to the medium opposed face side of the magneto-resistive effect film 1, for example.

[0047] Drawing 13 is the top view of the perpendicular energization mold magneto-resistive effect component concerning other operation gestalten. The electrode 2 in the component of drawing 13 has the die length larger than the depth from a medium opposed face which meets a medium opposed face, and has the same structure as drawing 1 except being an oblong configuration along with the medium opposed face.
[0048] With this structure, the linearity of the sense current field by the side of a medium opposed face becomes good, and counter acting effect with a bias field improves. Therefore, bias control of the magneto-resistive effect film 1 by the side of a medium opposed face becomes easier.
[0049] Drawing 14 and drawing 15 are the top views of the perpendicular energization mold magneto-resistive effect component concerning other operation gestalten, respectively. The component of drawing 14 has the same structure as drawing 13 except having retreated and having formed the bias impression film 3 rather than the medium opposed face of the magneto-resistive effect film 1. The component of drawing 15 has the same structure as drawing 14 except making width of face for a lobe of the magneto-resistive effect component 1 by the side of a medium opposed face into width of face almost comparable as an electrode 2.
[0050] With such structures, both, when the field from the bias film is too strong like [in case / with a narrow distance for example, between bias film / the linearity of the sense current field by the side of a medium opposed face becomes good and counter acting effect with a bias field improves], it becomes possible to apply the field of moderate magnitude to the medium opposed face side of the magneto-resistive effect film 1. Therefore, bias control of the magneto-resistive effect film 1 by the side of a medium opposed face becomes still easier.
[0051] Still like drawing 15 , if width of face for a lobe of the magneto-resistive effect component 1 by the side of a medium opposed face is made into width of face almost comparable as an electrode 2, lateral shape anisotropy can be given to the magneto-resistive effect film 1. Therefore, a shape anisotropy field can be added to a bias field, and the magneto-resistive effect film can be single-domain-ized still more easily.
[0052] Among the structures of the magneto-resistive effect component shown in drawing 1 and drawing 7 - drawing 15 , it is desirable like drawing 1 , drawing 8 , drawing 10 , and drawing 13 that the edge by the side of the medium opposed face of the magneto-resistive effect film 1 and the edge by the side of the medium opposed face of the bias impression film 3 have become the same flat-surface top. In this case, the effectiveness that a bias field becomes stability at the medium opposed face side of the magneto-resistive effect film 1, and also a production process also becomes easy is acquired.
[0053] Moreover, in drawing 1 , drawing 8 , drawing 10 , and drawing 13 , some magneto-resistive effect film 1 is used as a flux guide, and the thickness of a flux guide part is equal to the thickness of the magneto-resistive effect film 1 of other parts. The soft magnetism layer 11 which consists of NiFe etc. is formed between the magneto-resistive effect film 1 and a medium opposed face, a flux guide is formed, and you may make it the edge by the side of the medium opposed face of the soft magnetism layer 11 and the edge by the side of the medium opposed face of the bias impression film 3 become the same flat-surface top on the other hand, as shown in drawing 16 . In addition, the flux guide shown in drawing 16 may extend and form only the free layer of the magneto-resistive effect film 1 in a medium opposed face side. Also in this case, the effectiveness that a bias field becomes stability at the medium opposed face side of the magneto-resistive effect film 1, and also a production process also becomes easy since the process which forms a new layer is not required is acquired. Moreover, if it forms as mentioned above in a part of magnetic layer which was able to prepare the flux guide independently [the magneto-resistive effect film 1], or free layer of the magneto-resistive effect film 1, since a flux guide can be made thinner, it is advantageous to narrow-gap-izing.
[0054] Drawing 17 is the perspective view of the shielding mold magnetic head concerning 1 operation gestalt. In this drawing, the bottom serves as a medium opposed face. The electrode 2 which consists of Cu is formed in the upper and lower sides of the magneto-resistive effect film 1. The bias impression film 3 and 3 which becomes the both sides of the magneto-resistive effect film 1 from CoPt is arranged. This magneto-resistive effect component has the same structure as drawing 1 . Furthermore, the magnetic shielding 4 which consists of NiFe in contact with an electrode 2 is arranged. In addition, in this drawing, magnetic shielding of one side is omitting illustration.
[0055] Drawing 18 is the top view which looked at the shielding mold magnetic head of drawing 17 from the medium opposed face. Electrodes 2 and 2 are formed in the upper and lower sides of the magneto-resistive effect film 1. The bias impression film 3 and 3 is arranged at the both sides of the magneto-resistive effect film 1. Between the shielding 4 of a pair, and 4, these members are pinched, after the insulator layer 6 which consists of aluminum 2O3 etc. has insulated. With this operation gestalt, magnetic shielding 4 is formed as what serves as an energization lead.

[0056] In this shielding mold magnetic head, the energization direction of a sense current is decided so that the magnetization direction and sense current field of the bias impression film 3 which consist of CoPt by the medium opposed face side may be offset. Therefore, since medium magnetic flux flows into the magneto-resistive effect film 1 of electrode 2 directly under which is a magnetic force sencor, without being barred by the sense current field, the sensibility of the shielding mold magnetic head is maintainable.
[0057] In addition, drawing 1 , drawing 7 , or drawing 15 showed the example for which the end face by the side of the medium opposed face of an electrode 2 retreated from the end face by the side of the medium opposed face of the magneto-resistive effect film 1. However, since the direction of a bias field and the direction of a sense current field should just be anti-parallel substantially by the side into which the signal magnetic flux of the magneto-resistive effect film flows theoretically, not only these examples but the gestalt by which the end face by the side of the medium opposed face of an electrode 2 was formed in the medium twist rather than the same field as the end

face of the magneto-resistive effect film 1 or it is included in this invention.
[0058] Drawing 19 is the perspective view of the level York mold magnetic head concerning 1 operation gestalt. In this drawing, the bottom serves as a medium opposed face. The electrode 2 which consists of Cu is formed on the magneto-resistive effect film 1. The bias impression film 3 and 3 which becomes the both sides of the magneto-resistive effect film 1 from CoPt is arranged. Furthermore, magnetic York 5 which consists of NiFe which specifies a magnetic gap is formed in the magneto-resistive effect film 1 bottom. The electrode 2 is formed in the location [right above / the gap of magnetic York 5] shifted, and the magneto-resistive effect film 1 is located right above the gap of magnetic York 5. Magnetic York 5 located in the electrode 2 bottom functions as an electrode of another side.
[0059] In this level York mold magnetic head, the energization direction of a sense current is decided so that the magnetization direction and sense current field of the bias impression film 3 which consist of CoPt by the medium opposed face side may be offset in the part of the magneto-resistive effect film 1 located right above the gap of magnetic York 5. Therefore, since medium magnetic flux flows into the magneto-resistive effect film 1 which is a magnetic force sencor, without being barred by the sense current field, the sensibility of the level York mold magnetic head is maintainable.
[0060] Drawing 20 is the perspective view of the level York mold magnetic head concerning other operation gestalten. The level York mold magnetic head of drawing 20 has the same structure as drawing 19 except forming two electrodes 2 and 2 in the location [right above / the magnetic gap of magnetic York 5] shifted to a magnetic gap in the symmetrical location. Moreover, although illustration is omitted, a part for the magnetic gap point of magnetic York 5 is fill uped with Cu with conductivity higher than the magneto-resistive effect film. From one electrode 2, a sense current passes along Cu of the magneto-resistive effect film 1, magnetic York 5, and the magnetic gap section, magnetic York 5, and the magneto-resistive effect film 1 by this level York mold magnetic head, and flows to the electrode 2 of another side by it.
[0061] Also by this level York mold magnetic head, in the part of the magneto-resistive effect film 1 located right above the gap of magnetic York 5, the energization direction of a sense current is decided so that the magnetization direction and sense current field of the bias impression film 3 which consist of CoPt at a medium opposed face side may be offset. Therefore, since medium magnetic flux flows into the magneto-resistive effect film 1 which is a magnetic force sencor, without being barred by the sense current field, the sensibility of the level York mold magnetic head is maintainable.
[0062] Next, the magnetic-head assembly which carried the magnetic head concerning this invention, and the magnetic disk drive which carried this magnetic-head assembly are explained.
[0063] Drawing 21 (a) is the perspective view of a magnetic-head assembly which carried the CPP-GMR head. An actuator arm 201 has the bobbin section which the hole for being fixed to the fixed shaft in a magnetic disk drive is prepared, and holds the drive coil which is not illustrated. The suspension 202 is being fixed to the end of an actuator arm 201. The head slider 203 which carried the CPP-GMR head is attached at the tip of a suspension 202. Moreover, the writing of a signal and the lead wire 204 for reading are wired in a suspension 202, the end of this lead wire 204 is connected to each electrode of the CPP-GMR head included in the head slider 203, and the other end of lead wire 204 is connected to the electrode pad 205.
[0064] Drawing 21 (b) is the perspective view showing the internal structure of the magnetic disk drive which carried the magnetic-head assembly shown in drawing 21 (a). A spindle 212 is equipped with a magnetic disk 211, and it rotates by the motor which answers a control signal from the driving gear control section which is not illustrated and which is not illustrated. It is fixed to the fixed shaft 213 and the actuator arm 201 is supporting the suspension 202 and the head slider 203 at the tip. If a magnetic disk 211 rotates, the medium opposed face of the head slider 203 will be held where specified quantity surfacing is carried out from the front face of a magnetic disk 211, and will perform informational record playback. The voice coil motor 214 which is one sort of a linear motor is formed in the end face of an actuator arm 201. A voice coil motor 214 consists of magnetic circuits which consist of a permanent magnet countered and arranged so that the drive coil which was able to be wound up in the bobbin section of an actuator arm 201, and which is not illustrated, and this coil may be put, and opposite York. An actuator arm 201 is held by the ball bearing which was prepared in two upper and lower sides of the fixed shaft 213 and which is not illustrated, and has come to be able to perform rotation sliding free with a voice coil motor 214.
[0065] The magneto-resistive effect component concerning the various operation gestalten of this invention can be applied not only to a longitudinal magnetic-recording method but to the magnetic head or the magnetic recorder and reproducing device of vertical magnetic recording, and can acquire the same effectiveness. The thing equipped with the fixed record medium is sufficient as a magnetic recorder and reproducing device, and its record medium may be removable.
[0066] The magneto-resistive effect component concerning the various operation gestalten of this invention can be magnetically applied also to MRAM (Magnetic Random Access Memory) which can rewrite information, and can acquire the same effectiveness.
[0067] In addition, based on the operation gestalt mentioned above, all the magneto-resistive effect components, the magnetic head, and the magnetic storage regenerative apparatus which this contractor can carry out by carrying out a design change suitably also belong to the range of this invention similarly.
[0068]
[Effect of the Invention] As explained in full detail above, according to this invention, the magnetic head containing the perpendicular energization mold magneto-resistive effect component which can reduce the effect of a

perpendicular energization field, and this perpendicular energization mold magneto-resistive effect component, and the magnetic recorder and reproducing device which carried this magnetic head can be offered.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The top view of the magneto-resistive effect component concerning 1 operation gestalt.
[Drawing 2] The sectional view of the magneto-resistive effect film which consists of TMR film.
[Drawing 3] The sectional view of the magneto-resistive effect film which consists of CPP-GMR film.
[Drawing 4] The sectional view of the magneto-resistive effect component concerning 1 operation gestalt.
[Drawing 5] The sectional view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 6] The sectional view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 7] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 8] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 9] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 10] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 11] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 12] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 13] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 14] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 15] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 16] The top view of the magneto-resistive effect component concerning other operation gestalten.
[Drawing 17] The perspective view of the shielding mold head concerning 1 operation gestalt.
[Drawing 18] The top view which looked at the shielding mold head of drawing 17 from the medium opposed face.
[Drawing 19] The perspective view of the level York mold head concerning 1 operation gestalt.
[Drawing 20] The perspective view of the level York mold head concerning other operation gestalten.
[Drawing 21] The perspective view of the magnetic-head assembly concerning 1 operation gestalt, and the perspective view showing the internal structure of a magnetic disk drive.
[Drawing 22] Drawing showing the relation between electrode size and the maximum magnetic flux density in a hysteresis loop applied to the magneto-resistive effect film in the edge section of an electrode.
[Drawing 23] Drawing showing the relation between the magnitude of a sense current, and the maximum magnetic flux density in a hysteresis loop applied to the magneto-resistive effect film in the edge section of an electrode.
[Description of Notations]
1 — Magneto-resistive effect film
2 — Electrode
3 — Bias impression film
4 — Magnetic shielding
5 — Magnetic York
6 — Insulator layer
11 — Soft magnetism layer
21 — Substrate layer
22 — Antiferromagnetism layer
23 — Magnetization fixing layer (pin layer)
24 — Tunnel junction layer
25 — Magnetization free layer (free layer)
26 — Protective layer
31 — Substrate layer
32 — Antiferromagnetism layer
33 — Magnetization fixing layer (pin layer)
34 — Nonmagnetic interlayer (spacer layer)
35 — Magnetization free layer (free layer)
36 — Protective layer
201 — Actuator arm
202 — Suspension
203 — Head slider
204 — Lead wire
205 — Electrode pad

211 -- Magnetic disk
212 -- Spindle
213 -- Fixed shaft
214 -- Voice coil motor

[Translation done.]